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Technological Advances to Assess, Manage and Reduce Ice Risk in Northern Developments

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Abstract

As the number of oil and gas players in Arctic and sub-Arctic regions increases, so do the suite of technology-based capabilities for cold region operations. Advances are being made in remote sensing, ice management, and ice engineering. R&D targeted to increase our understanding of the ice environment and ice mechanics is reducing uncertainties relating to ice loads. C-CORE and partners have been developing and providing technical solutions to most recent oil and gas initiatives facing the challenge of sustainable development in ice covered regions. Using this work as background, this presentation will highlight recent and imminent technological advances providing near-term improvement in the economics of cold ocean hydrocarbon production.

Background

Offshore oil and gas exploration began on the Grand Banks of Newfoundland in 1966 with the first major discovery, Hibernia, occurring in 1979. The discovery of Hibernia was the result of a joint exploration venture by Chevron and Mobil. Other major oil and gas discoveries on the Grand Banks followed with Hebron in 1981 and the White Rose and Terra Nova Fields in 1984. First oil was produced from Hibernia in 1997, Terra Nova in 2002, White Rose, 2005 with Hebron expected to be 2017-18. A number of R&D initiatives were undertaken in order to develop these resources safely and in the most cost effective manner possible. In the early 1980s comprehensive data collection programs were initiated by Mobil to develop a design basis for the Hibernia development (Dobrocky, 1984). Aerial surveys were conducted for above water iceberg characterization (size and mass) as well as iceberg profiling for below water geometry for mass. In 1996, Grappling Island iceberg impact experiments were carried out; the first ever iceberg impact experiments (Ralph et al, 2004). Research and development into ice mechanics and design load algorithms pioneered by Dr. Jordaan at the Ocean Engineering Research Center at Memorial University Canadian Offshore Design for Ice Environments (CODIE) project have made a tremendous impact in design for these harsh environments (CODIE I, 1997 and CODIE II, 2003). More recently, an improved understanding of ice mechanics and failure processes have led to an improved basis for global design loads based on a reduced iceberg pressure on large contact areas from 6.0 MPa used in the Hibernia design basis to a still conservative 1.5 MPa presently used for Hebron studies.

From 1999 to 2005, C-CORE led a comprehensive Ice Management R&D JIP addressing technology challenges relating to detection and towing. Research and development continues with improvements and optimized methods for ice management (detection, forecasting, threat analysis, decision-making and iceberg towing), the modeling of ice management effectiveness for design, and improved methods for iceberg collision and design load analyses.

Ice management has two components when referencing design for operations in arctic regions. First, it ensures an offshore structure has adequate resistance or reinforcement to sustain loading from ice interaction. Second, it is protection of a facility using active intervention to prevent interaction with extreme features. Possible scenarios